Education/Public Outreach

The Laboratory of Terrestrial Physics' Education and Public Outreach Program supports exploration and discoveries of Earth and Planetary Science to the public. The Program is a comprehensive resource for research conducted by the Laboratory and promotes scientific literacy and awareness of Earth and Planetary Science. The Laboratory's Program aligns with NASA's education objectives to enhance educator knowledge and preparation, develops supplementary curricula, forge new education partnerships and supports all levels of students. The Laboratory's staff is a cooperative team supporting these objectives through formal and informal education and in public outreach avenues. Two of the Laboratory's premier educational projects are GLOBE and IMAGERS, detailed in the following section.

GLOBE (Global Learning and Observation to benefit the Environment)

GLOBE is an International partnership between scientists and primary education students and teachers, working together to increase environmental awareness of individuals throughout the world, help students reach higher levels of achievement in science, mathematics, and technology, and provide a source of data for scientific research. Measurement protocols and learning activities have been designed by scientists to teach students how to understand Earth science concepts in the areas of soil, land cover and biometry, hydrology, and atmosphere/climate. GLOBE students make regular measurements using these protocols and report data via the Internet to a main data archive where they are available to the scientific community. GLOBE is active in over 10,000 schools in more than 97 countries worldwide.

Within the Biospheric Sciences Branch, Dr. Elissa Levine is the Principal Investigator for the Soil Investigation of GLOBE. She and her staff use the data for Earth science research as well as work to support the protocol, learning activities, and outreach for the GLOBE soil Investigation. Research components using GLOBE student data include: assessment of changes in soil properties due to acid precipitation inputs, soil moisture and temperature modeling with the GAPS (General Atmosphere-Plant-Soil model), modeling the relationship between soil color and soil properties using neural networks, and others.

Outreach Activities include:

- Development of new protocols and learning activities for the new edition of the GLOBE Teacher's Guide;

- Continued development of a Soil Science Education Web Page;

- Numerous domestic and International GLOBE training including: Gallaudet University; Kathmandu, Nepal; special workshop for Tribal Colleges; and others;

- Presentation of an International GLOBE Soil Symposium in Chaing Mai, Thailand;

- Web chats with GLOBE students;

- Interview for PBS feature (American Environmental Review) on soils and GLOBE, Development of Girl Scout "Soil badge"

- Presentations at Girl Scout Day, NASA/GSFC Earth Awareness Day,

- Assistance with development of Soil Science Curriculum material for 4H

- Participation in Women in Science and Engineering- WISE- program through summer intern;

- Collaboration with the Soil Science Society of America (SSSA) with USDA/ NRCS and the Smithsonian Institution to develop of a soil exhibit at the National Museum of Natural History;

- Journal publication, and numerous oral and poster presentations.

Web sites: http://ltpwww.gsfc.nasa.gov/globe/index.htm and http://www.globe.gov

Contact: Elissa Levine, elissa@ltpmail.gsfc.nasa.gov

IMAGERS (Interactive Multimedia Adventures for Grade-school Education using Remote Sensing)

Interactive Multimedia Adventures for Grade-school Education using Remote Sensing (IMAGERS) Program develops educational tools for teaching remote sensing as part of the Earth science curriculum under the direction and support of the Laboratory for Terrestrial Physics. The Program began in 1998, with a dual online and classroom component, in the interactive Web site titled Echo the Bat. Over the years IMAGERS has grown to include two of NASA's premier Earth Science Enterprise educational projects, Echo the Bat and Amelia the Pigeon, with a number of informal and formal education tools.

The focus of the initial project, Echo the Bat, was an understanding of light and the electromagnetic spectrum as a foundation for remote sensing through an interactive adventure game. The introduction of remote sensing to children facilitates the understanding of studying earth science from space, specifically the areas of ecology, geology, and biodiversity.

The Adventure of Echo the Bat Project encompasses:

- An Echo the Bat picture book is accompanied by a set of activities, which reinforces four basic themes or concepts fundamental to the interpretation of satellite imagery: perspective, shape and pattern, color, and texture. The book was published in 2001.

- An interactive Web site that follows Echo as he migrates through Arizona. It teaches students the "understanding of light" and the "electromagnetic spectrum" as a foundation for remote sensing. The adventure offers a directed and investigative approach to how land features look from space. The site is supported with an extensive teacher's guide. The Web site is continually update with new activities and resources information for teachers and the general public.

- The Laboratory is launching a new education project with Grand Canyon National Park, Arizona State Parks, and the Arizona Science Center in the summer of 2002. Located in five different geographic regions of Arizona, each location will feature an interactive game display, accompanied with an activity booklet. Each of these locations have education specialists who interact daily with school groups and visiting children at their facilities.

Figure 1. The Adventure of Echo the Bat (left) and The Adventures of Amelia the Pigeon (right).

The Amelia the Pigeon Adventure is a new and exciting interactive Web site that is scheduled for fall 2002. Set in New York City, the product will present science concepts using a Pigeon as a metaphor to introduce the concept of perspective and change in urban habitats. Specifically, Amelia teaches children grades K-4 the fundamentals of land images and land use over time. The product focuses on the benefits of a bird's eye view then introduce the advances of remote sensing throughout the century. Students will be challenged to solve problems based on historical information gathered from the Pigeon's adventure and visual cues in the satellite imagery.

Web site: http://imagers.gsfc.nasa.gov

Contact: Ginger Butcher, ginger@ltpmail.nasa.gov

EOS Terra Rapid Response

A central part of Terra's outreach objective is to get Terra's remote sensing images picked up and published by the mainstream news media (TV, newspapers, Web sites, magazines, etc.). Landsat-7 images are also included as part of the operation, since that mission flies in formation with Terra. The problem is three-fold. First, news worthy events must be known as soon as possible while the story is still fresh. Second, Terra &/or Landsat data must be acquired and processed in a timely manner (within 12 to 48 hours of acquisition). The third part of the problem lies in attracting the media's attention to these images once they are made so that they will use them.

To encourage the public media to seek out EOS Terra stories a new section within the Earth Observatory was constructed entitled Natural Hazards. Unveiled on January 16, 2002, the Natural Hazards section is analogous to NOAA's Operational Significant Events Imagery site. The intent is to train the public media to expect to find high quality imagery from NASA's sensors, thereby calling attention to the remote sensing technology being developed and operated by NASA. Initially, the Natural Hazards section is divided into, and tracks Earth events in, five main categories: dust and smoke events, fires, floods, severe storms, and volcanoes.

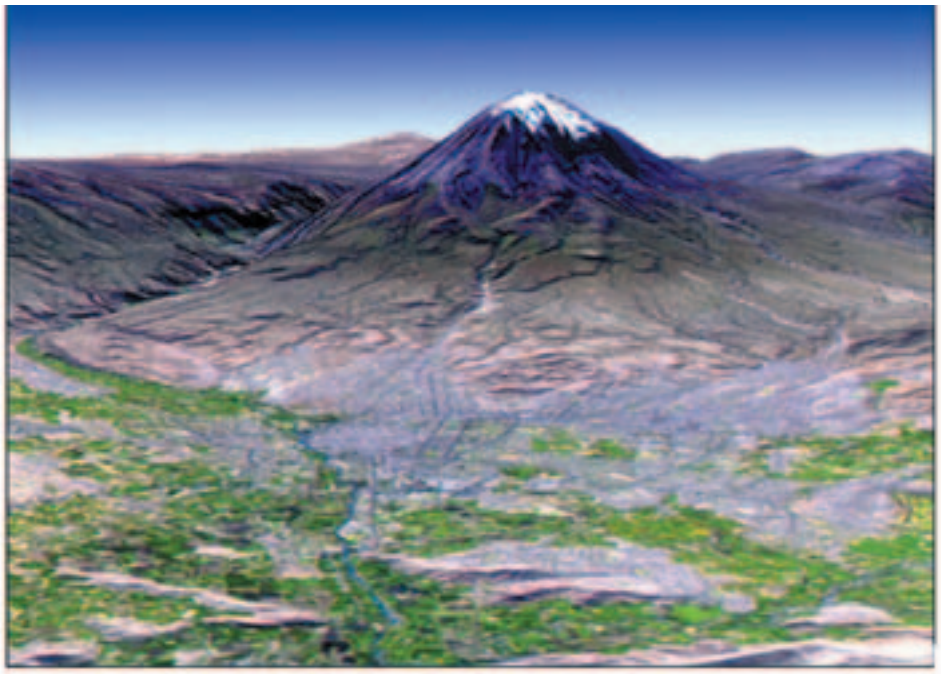


Figure 2. This three-dimensional perspective view was created from ASTER.

This three-dimensional perspective view was created from an Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Digital Elevation Model combined with a simulated natural color ASTER image, acquired July 13, 2001. It shows El Misti volcano towering 5822 meters high above the second city of Peru, Arequipa, with a population of more than one million.

Figure 3. A new Natural Hazards section the of the Earth Observatory was unveiled in January 2002.

A new Natural Hazards section the of the Earth Observatory was unveiled in January 2002.

Web sites: http://rapidfire.sci.gsfc.nasa.gov and http://earthobservatory.nasa.gov/NaturalHazards/

Contact: Jon Ranson, jon.ranson@gsfc.nasa.gov

University Programs

There are several types of university programs within the Laboratory. Some of these are NASA programs, some are exclusive to the Earth Science Directorate, and some are joint projects with university personnel.

In the first category there is the National Research Council (NRC) Resident Research Associateship (RRA) for post doctorate investigations. During the year 2001 the Laboratory hosted two persons in this category. There is the Undergraduate Student Research Program where students are sponsored at their home university for up to three years. Currently there are two persons in this category but more are expected in the near future. These programs are administrated locally by the GSFC University Programs Office and described in their web page http://university.gsfc.nasa.gov/index.html

In the second category we have formal joint programs with several universities. These include the Joint Center for Earth Systems Technology (JCET) with the University of Maryland/Baltimore County. There is the Goddard Earth Science and Technology Center (GEST) sponsored by the University of Maryland, Howard University, Hampton University, Caelum Research Corporation and Northrop Grumman Corporation. The Earth Systems Science Interdisciplinary Center (ESSIC) is with the University of Maryland/Collage Park. With the Massachusetts Institute of Technology there is the Joint Center for Geoscience (JCG) and the Joint Center for Observation System Science (SCOSS) with the Scripps Institute of Oceanography, University of California, San Diego. The most active programs during the year 2001 have been with JCET, GEST, and JCG where there have been exchanges of faculty and research personnel. These programs and others within the Earth Science Directorate are described on the web page http://earthsciences.gsfc.nasa.gov/collab.html.

Maria Zuber and David Smith organize the MIT/Goddard Course on Remote Sensing. An Independent Activity Period, which lasts 1 to 3 weeks, is offered to junior, senior, and first-year graduate students. The course is offer yearly, on the Techniques of Remote Sensing, and is limited to 12 students. The course is taught at MIT and at Goddard. The course is concentrated on current issues. The MIT description of the course follows:

A practical introduction to techniques for observing the Earth from airborne and spaceborne platforms. Topics include spacecraft design, data handling, cryogenic instrumentation, magnetometry, radar altimetry, atmospheric and altimetric lidars, microwave and laser interferometry, gamma ray and x-ray technology, mass spectrometry and imaging spectrometry. Part of the course is taught at GSFC where students will participate in tours of laboratories to observe sensor development in progress, mission operations facilities to view real-time data collection, and computational facilities to participate in data processing and analysis.

Formal (K-12, Undergraduate and Graduate) Education and Outreach

Formal Science Education includes teaching and learning about Earth system science at elementary, secondary, undergraduate and graduate levels. Both curriculum materials and supplemental resources are included with presentations and workshops. Formal education outreach enhances established curriculum for both students and teachers. Some examples of the types of activities in which the Laboratory was involved in 2001 follow.

Susan Sakimoto taught "Understanding and Teaching the Solar System" Course at John's Hopkins University's Master of Science in Education Program for spring 2001. This is primarily for secondary (middle and high school) science teachers. It required both a Space science textbook and the National Science and Education Standards and Benchmarks books as texts. This is a three-

credit graduate course in education. Sakimoto used NASA education materials and current mission Web sites in homework and class exercises.

Jeffrey Privette and Jon Ranson co-taught a graduate level course entitled "Remote Sensing: Earth Observing Systems and Applications" at Johns Hopkins in Environmental Science and Policy Program in the spring 2001.

Richard Kay, John Degnan and D. Barry Coyle were panel members for the Doctoral Thesis defense of Mr. Samuel Gompers; an American University graduate student in Physics. Gompers has been working in Code 920.3 for three and a half years under the auspices of Goddard's Graduate Student Research Program managed by Code 160.

Cynthia Hamel supported GSFC Education Resource Center by participating in a hands-on discovery workshop for local teachers in February 2001. Participants completed hands-on activities that introduced them to the MOLA, Mars Pathfinder and Polar Lander instruments and their products. There were a total of approximately 30 teachers who participated.

James Abshire and Robert Afzal served as judges for the Howard County Science Fair in March 2001.

Carey Noll gave a presentation to the 5th grade classes at Holy Trinity Episcopal Day School in Glenn Dale. She addressed the Project Starship as well as other projects she is currently working on at Goddard. Noll also served as a judge at the Glenn Dale Elementary School Science Fair in March 2001.

Jon Ranson was a guest scientist on Step Star Network's Young Astronaut program in April 2001. The Young Astronaut program is a space oriented educational course given to 4th and 5th graders via live television hook up in their classrooms. Ranson presented information and results from the EOS Terra Mission and answered student's questions during the half-hour broadcast.

Darrel Williams was a guest lecture at Howard University in April 2001.

Darrel Williams chaired a Technical Review Committee to review the progress being made at the University of Puerto Rico at Mayaguez under a second five-year NASA grant to this minority institution. Marc Imhoff of Code 923, and Jonathan Rall of Code 924, also attended.

Greg Neumann gave a presentation in May 2001 to the Friends School of Baltimore. Neumann presented a slide show, Mars Maps, an Earth Globe and a Mars Globe to the Robotics Club, which included 6th, 7th, and 8th grade students. The students were most impressed with "real science" and how "discoveries" can be made.

Cynthia Hamel participated in the Wilde Lake Middle School Field Day in May 2001 at Mount Pleasant Farm, Howard County, MD. She gave programs on soil and geology to approximately 100 8th grade students and utilized two soil pits as well as different soil samples. The students were also required to conduct a plot survey and identify plant species within the plot. Hamel discussed the importance of geology, soil to plant species, stream erosion, and buffer zones.

Paul Lowman presented to teachers from Anne Arundel Public Schools in July 2001. Lowman presented research information on remote sensing and plate tectonics, and available education resources.

Jeanne Sauber addressed approximately twenty college faculty members from non-Ph.D. science institutions in July 2001. The purpose of the talk is to increase GSFC's visibility at institutions that don't traditionally receive NASA grant funding by informing them about GSFC's research,

NASA missions, sources of additional information, and possible education/research opportunities for staff and/or students.

Jeanne Allen presented an overview of Landsat applications and Multi-Spectral software to a group of teachers from Anne Arundel Public Schools in July 2001.

Jon Ranson visited Patapsco Middle School in Ellicott City, MD in November 2001 and discussed remote sensing of the solar system.

Frank Niepold gave a workshop for educators grades 5-12 titled "Using Landsat Imagery in the Classroom". The workshop included hands-on training with the Landsat Imagery and essential software, developed at NASA for the study of Earth Systems Science. The hands-on lessons will incorporate remote sensing to study dynamic earth systems and thereby monitor and predict changes that will effect the planet.

James Smith is a member serving on the Ph.D. committee in the Department of Computer Science and Electrical Engineering at University of Maryland Baltimore County.

James Smith as a Program Evaluator for the Computing Accreditation Commission of Accredited Board Engineering Technology (ABET). As such, he was a member of the Accreditation Team that evaluated the undergraduate Computer Science Program at Southwest Missouri State University

Elissa Levine taught a graduate course on Soils at John Hopkins University in the Environmental Science and Policy Program.

Jeffrey Privette was a guest lecture in the graduate Geography course Remote Earth Observations, "Development of a new environmental Science and Policy Program".

Jon Ranson taught a graduate level course on Earth Science to K-12 teachers at John Hopkins University.

Compton Tucker was a visiting scholar at the University of California at Berkeley and co-taught an Introduction to Remote Sensing course.

Darrel Williams was a guest lecture at the Kennedy Space Center on Spaceflight and Life Sciences Training summer program.

Darrel Williams gave two seminar presentations at the Australian National University in Canberra on Landsat-7 and Terra.

Darrel Williams gave a seminar to science students and professors at Western Maryland College.

The Laboratory has been involved in the development of the remote sensing program at the Uniformed Services University of the Health Sciences in Bethesda, Maryland for the last five years. The LTP provided technical advice and funding for teaching and collaborative research. A graduate course, Remote Sensing and GIS Methods in Public Health, had been taught four times as of fall, 2001. The LTP has also assisted in the system administration of the USUHS remote sensing/GIS computer lab. The lab is used to teach a graduate course, Remote Sensing and GIS Methods in Public Health. The lab is also used for student projects, dissertations and faculty research.

Informal (Parks, Museums, Visitor or Technology Centers) Education and Outreach

Informal Science Education provides rich and stimulating opportunities outside formal school settings, where individuals of all ages, interests, and backgrounds are provided the opportunity to increase their appreciation and understanding of Earth and planetary science. Informal science education outreach projects support learning in various venues including museums, science centers, public lands management groups and community groups, youth groups, and the mass media. Examples are included below.

Cynthia Hamel presented at a GIS workshop in support of the Chesapeake Bay Foundation in January 2001. The workshop was to provide instruction for watershed managers in the use of GIS, GPS and remote sensing for site design, stormwater control, and decision-making processes. There were three workshops. The first addressed ArcView Software and took place at UMBC, Catonsville. The second was a field based instruction with GPS and took place at Cary Murray Outdoor Education Center in Baltimore. The third addressed the conduct of education and outreach and took place at the Center for Watershed Protection in Ellicott City.

Susan Sakimoto appeared on a Learning Channel special titled The Ultimate 10 Thrill Rides. She added a little volcanology science content for the segment on the Volcano the Blast Roller Coaster.

Cynthia Hamel conducted an on site field trip to the Visitor Center for approximately 30 Boy Scouts in February 2001.

Janice Wiles, Education and Outreach Coordinator for LBA, developed the GTDC (LBA Communication and Outreach Working Group – Grupo de Trabalho de Divulgacao e Communicacao) in April 2001. The Group will provide support personnel whose interest involves training in media, communication, and environmental education.

Cynthia Hamel gave a presentation to the Dasher Green School in Columbia in April 2001. Hamel's presentation was about Space Exploration and showed images of Mars and the Earth and discussed what is required for exploration and why it is important.

Cynthia Hamel attended Fair St. Louis, Gateway National Park, St. Louis, MO. Hamel gave several presentations on remote sensing, how satellites work, and programs which NASA and the National Park Service has developed. KMOX 1380 public radio station from St. Louis, MO interviewed Hamel.

Stephanie Stockman did a Landsat-7 display, which also included Echo the Bat, at the USGS Open House in Reston, VA, April 2001.

Janice Wiles and Ivani Pereira, LBA Education and Outreach, gave a presentation in May 2001 to approximately 250, 4th and 5th grade students, teachers, administrators, community leaders and visiting parents at the Maine Space Day Brunswick, Brunswick, MA. They presented a science talk with the 5th graders and discussed the importance of satellites in understanding the Earth. Then they presented a slide show at a general assembly, which addressed the overall importance of global climate.

Stephanie Stockman presented an overview of Landsat-7 education in June 2001 to a group of Native American teachers from the Salish and Koopenai tribes. Stockman provided K-4 educational activities in Earth science.

Figure 4. Ginger Butcher conducts a children's workshop on remote sensing at the GSFC Community Day in June 2001. Community Day was also hosted the augural production of the Echo the Bat Puppet Show, which is now permanently available at the Visitors Center.

Cynthia Hamel supported the GSFC Education Office's, Summer Institute in Science, Technology, Engineering and Research (SISTER) as a mentor. Hamel hosted four junior high school female students for a one-day job-shadowing session.

Cynthia Hamel hosted a Native American Summer Intern in July 2001. The Intern was interested in Earth Sciences and shadowed Hamel and other Laboratory personnel.

Cynthia Hamel and Gunther Kletetschka supported the GSFC Special Programs Office in attending a dinosaur dig in northeastern Colorado near Dinosaur National Park. While providing geological information, they also recorded a hour videotape about the dig.

Conferences, Presentations, and Seminars

The Laboratory staff continually speaks and presents at education conferences and seminars, in an effort to share their research with the general public and scientific community. Informing the general public on the activities within the Laboratory is a critical component to our outreach objectives and goals.

Marc Imhoff served as a panelist and keynote speaker at two separate international workshops on remote sensing and geo-spatial technology for international treaty compliance and verification and law enforcement for international eco-crimes. Imhoff was asked as ESSP Project Scientist to give an overview of NASA technology and NASA ESE remote sensing resources in the context of environmental monitoring to a group of over 200 at the NYU School of Law - Combating International Eco-Crime in a global Economy. Imhoff was also invited as a Panel member and Co-chair of a workshop on Remote Sensing and Environmental Treaties in December 2000, at the Woodrow Wilson International Center in Washington DC. Dr. Imhoff was asked to take a leadership role in both of these workshops as a result of his previous involvement with ISPRS and the treatment of potential remote sensing application to issues relating to the Kyoto Protocol.

Darrel Williams gave a Landsat status update talk at the EOS IWG meeting in Ft. Lauderdale, Florida. Sam Goward and Jim Irons also coordinated talks on Landsat 7 science results and the LDCM.

Darrel Williams was a guest lecture at Howard University in April 2001, focusing on Remote Sensing and use of Landsat data in exploring the Biosphere. The students attending were from two classes: (1) The Remote Sensing Graduate class of Dr. Vernon Morris. These were MS and Ph.D students in Atmospheric Science, and (2) The Digital Media Applications class, consisting of BS, MS and Ph.D Computer Sciences, Business and Arts Students. Several students expressed interest in exploring summer and year round intern/work at Goddard as a result of this presentation.

Marc Imhoff gave an invited plenary talk at the 10th Brazilian Remote Sensing Symposium in Foz do Iguacu, Brazil in April 2001, about "Remote Sensing tools for Carbon Cycle Science in the Context of the Kyoto Protocol or Carbon Related International Treaties."

Elizabeth Middleton and her Vegetation Fluorescence Team gave a presentation to management personnel at the Defense Tactical Response Agency in Herdon, VA in April 2001. The presentation provided background information on the capabilities of using evolving fluorescence technologies to monitor environmental impacts on vegetation, and the potential for use with specific plant species as detectors of negative impacts by chemical agents in the soils.

Paul Lowman had an article accepted in The Science Teacher magazine, May 2001. The article titled Evidence From Apollo, pp22-25 addressed the "conspiracy theory" which says that astronauts did not land on the Moon.

Darrel Williams attended the ISSSR 2001 symposium in Quebec City, Quebec, Canada in June 2001 and presented a status update about the success of the Landsat 7 mission.

Darrel Williams did a trip to the Kennedy Space Center in June 2001, for a guest lecture to students attending the Spaceflight and Life Sciences Training summer program. The focus of the talk was on a remote sensing tutorial and use of earth observation data in exploring the Biosphere.

Stephanie Stockman presented a remote sensing workshop for summer interns working within the Laboratory in July 2001. The workshop included an overview of remote sensing with an emphasis on applications of Landsat data. Approximately ten participants were also trained to use MultiSpec to process and analyze remote sensing data. Stockman also presented an overview of Landsat 7 Education and Outreach to the Landsat 7 Science Team in Honolulu Hawaii.

Darrel Williams prepared and submitted a short paper on Landsat 7 to the IGARSS 2001 symposium in Sydney, Australia in early July. Also a presentation was given on a status update about the success of the Landsat 7 mission after two years in orbit. During the IGARSS 2001 symposium, also presented a paper on behalf of Guoqing Sun, Dr. Williams, and others involved in our proj-

ect to map the forests of NE China. Later, gave back-to-back seminar presentations at the Australian National University in Canberra on Landsat–7 and Terra, respectively.

John Degnan's The IIP Airborne MultikHz Microlaser Altimeter paper was featured as a poster at a booth at the GSFC Technology Workshop and was the subject of several invited papers at the following conferences: Earth Science Technology Conference at the University of Maryland in August; the SPIE/Europto Laser Radar Conference in Toulouse, France, in September 2001; and the Laser Altimetry Workshop in Annapolis in October 2001. A comprehensive manuscript on the theory of operation was submitted as an invited paper to the Journal of Geodynamics Special Issue on Laser Altimetry.

Darrel Williams presented a guest seminar to a group of science students and professors at Western Maryland College in November 2001. The seminar provided a brief tutorial on what remote sensing is all about, followed by several examples of stunning images and/or applications using Landsat data.

Elizabeth Middleton presented a paper at the Workshop on "UV Impacts on Aquatic and Terrestrial Ecosystems," held in November 2000 in conjunction with the tratospheric Processes and its Role in Climate (SPARC 2000) Conference in Mar del Plata, Argentina. Her paper was entitled "Evaluating Ultraviolet Radiation Exposures Determined from TOMS Satellite Data at Sites of Amphibian Declines in Central and South America."

For information regarding education and public outreach activities and programs visit:

Web site: http://ltpwww.gsfc.nasa.gov/education

MK Richardson, mkrichardson@ltpmail.gsfc.nasa.gov

Strategic Plan for the Future

The research, development, and baseline monitoring activities conducted within the Laboratory for Terrestrial Physics are extremely diverse, innovative and exciting. Our programs range from instrument development (particularly laser) and/or calibration, to measuring and modelling regional to global scale vegetation and biosphere-atmosphere interations using both passive and active forms of remote sensing, to studies of the physics and dynamics of the solid Earth, the planets and their satellites, to large scale data processing. Short of having our own launch capabilities, we literally cover the full range of capabilities and services from conceiving a measurement or mission; building, testing and/or calibrating the instrumentation needed to make the desired measurement(s); to processing the raw data into useable products; to ensuring the scientific integrity of these missions. This diverse range of capabilities, responsibilities, and activities present opportunities, as well as challenges. We certainly feel that the positive aspects of dealing with this exciting set of activities far exceed any hindrances and roadblocks. The biggest challenges that we face are in hiring and maintaining a workforce of an appropriate size and a range of experience to cover all of the tasks that need to be addressed in order to be successful in such undertakings. Other challenges involve physical space allocations and the consistency and adequacy of fiscal support.

We are very positive and excited about our recent past, the present, and the future. Laboratory personnel have played, and will continue to play significant roles in ushering in the most data rich period in history for both Earth and extraterrestrial observations. The past few years have also resulted in enhanced collaboration between the "bio," "geo" and "laser" groups within the Laboratory for conceiving and/or implementing innovative missions to acquire profiles of vegetation canopies and the underlying terrain, or for assessing CO_2 concentrations in the atmosphere. We are well equipped and aligned to play a significant role in our nations carbon budget initiative. We consider the multidisciplinary nature of our activities, and our collaborative efforts with our colleagues in academia and other national and international institutions to be our strength.

Acknowledgements

The Laboratory for Terrestrial Physics would like to recognize its members for their hard work and accomplishments. This report is proof of the outstanding work they do.

We'd like to thank the Goddard, national, and international communities for their contributions and collaborations with us. We'd like to especially recognize the Massachusetts Institute of Technology (MIT), Scripps Institute of Oceanography, the University of Maryland (UMD) College Park and Balitmore campuses, and the Earth Resources Observation Systems (EROS) Data Center (EDC) for their collaborative efforts.

We would like to thank all who contributed time from their busy schedules to contribute to this report, especially the Branch Heads and their teams. Special thanks to Arlene Kerber. Our thanks go out to the Branch and Office secretaries and administrators.

Thanks go to Maggie Masetti who organized and complied the report, and for her formatting and layout of the finished product. Thanks to MK Richardson whose editorial expertise and hard work helped the text of the report to flow smoothly.

Appendix 1 - Visitors & Summer Personnel

Visitors for the Biospheric Sciences Branch

Dr. Ganapati Patil, Pennsylvania State University, December 3, 2001

Lisa Ojanan, Self, November 8, 2001

Abel Muzein, Self, November 5, 2001

Meredith Walz, Sef, November 5, 2001

Peter Hardy, GLOBE Certified Trainer, Global Learning to Benefit the Environment (GLOBE) Program, Australia, November 26 - June 30, 2002.

Saulo dos Santos, President of Infrastructure for Large-Scale Biosphere Atmosphere Experiment in Amazonia (LBA) Ecology Program, Brazil, November 14, 2001.

Claudia Nogueira, Vice President of Infrastructure for Large-Scale Biosphere Atmosphere Experiment in Amazonia (LBA) Ecology Program, Brazil, November 14, 2001.

Dr. Brian J. Turner, Australian National University, November 15, 2001.

Dr. John Reagan, University of Arizona, Arizona, October 15-16, 2001.

Graduate Students from University of Maryland, Department of Geography, College Park, Maryland, October 2 - April 2, 2001:
Jill Eastman
Ruth DeFries
Charlene Dimiceli
Matthew Hansen
Robert Sohlberg
Mark Carroll
Paul Davis
Bethany Semeiks

David Jackson, student from University of Maryland, College Park, Maryland, September 24 - December 31, 2001.

Professor Henry D. Snyder, faculty member from Gallaudet University, Chemistry and Physics Department, Washington, D.C., August 27, 2001 - February 27, 2002.

Mr. James D. Soukup, Senior Project Engineer, The Aerospace Corporation, Chantilly, VA, September 28, 2001 - March 28, 2002.

Mr. Mark Chatelain, Engineering Specialist, The Aerospace Corporation, Chantilly, VA, September 18, 2001 - October 31, 2002.

Dr. Samuel N. Goward, University of Maryland, Department of Geography, College Park, Maryland, September 18, 2001 - March 28, 2002.

Raymond Byrnes, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD, September 18,

2001 - March 18, 2002.

Dr. Chris Justice, University of Maryland, Department of Geography, College Park, Maryland, September 4, 2001 - March 4, 2002.

Laura Kimes, Eleanor Roosevelt High School, Greenbelt, Maryland, September 4, 2001 - March 4, 2002.

Sara Rosenberg, Science Systems & Applications, Inc., Lanham, Maryland, September 2 - November 2, 2001.

Susan Jones, Director of Systems Architecture and Engineering Department, The Aerospace Corporation, August 2, 2001 - February 28, 2002.

Dr. Roger C. Burk, U.S. Military Academy, West Point, New York, July 31 - October 31, 2001.

Dr. James Wilson, World Health Organization, August 1 - September 28, 2001.

Chris Neigh, University of Maryland, Department of Geography, College Park, Maryland, July 23, 2001 - January 23, 2002.

Dr. John Townsend, Professor, University of Maryland, Dept. of Geography, College Park, Maryland, July 18, 2001 to January 18, 2002.

Jon Parsons, summer student from Middlebury College, Middlebury, Vermont, July 9 - August 20, 2001.

Mark Miskolciz, Self, June 19 - August 31, 2001.

Kendra Drob, George Mason University, Fairfax, Virginia, May 23 - December 31, 2001.

James Storey, Raytheon ITSS, June 2 - December 2, 2001.

Graduate Students from University of Maryland, Department of Geography, College Park, Maryland, May 1 - October 1, 2001.
Jill Eastman
Ruth DeFries
Charlene Dimiceli
Matthew Hansen
Robert Sohlberg
Mark Carroll
Paul Davis

Dr. John Townsend, Professor, University of Maryland, Dept. of Geography, College Park, Maryland, May 3 - November 3, 2001.

James Blackburn, Compaq Computer, April 26 - October 26, 2001.

Nicole Owe, University of Maryland, College Park, Maryland, March 28 - December 31, 2001.

Darold Ward, Self, March 6 - April 6, 2001.

Raymond Byrnes, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD, March 9 - September 9, 2001.

Lawrence R. Pettinger, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD, March 9 - September 9, 2001.

Shadan Haghani, River Hill High School, Columbia, Maryland, March 2 - September 2, 2001.

Mary Jane Sasser, River Hill High School, Columbia, Maryland, March 2 - February 23, 2001.

Dr. Christopher Justice, University of Virginia, Dept. of Environmental Sciences, Chantilly, Virginia, February 12 - August 12, 2001.

Darold Ward, Self, February 8 - March 8, 2001.

Attendees of Resource21 Meeting, February 6, 2001:
Vic Leonard, CEO, Resource21
Tom Koger, Director, Govt Markets
Vic Sweberg, Boeing, R21 Program Manager
Pete Gerber, Boeing, R21 Ground Segment Manager/LDCM Project Lead
Livingston Holder, Boeing, R21 Collection Segment Manager
Mike Sweat, Farmland Industries, R21 Board Member

Dr. Samuel N. Goward, University of Maryland, Department of Geography, College Park, Maryland, February 3 - August 3, 2001.

Visitors from Lockheed Martin, meeting with Jim Irons, Landsat Data Continuity Mission (LDCM) project, January 23, 2001.
Frank Avila
Braxton Baldridge
Mary Pagnutti
Bob Ryan
Greg Snyder

Phuc Nguyen, Eleanor Roosevelt High School, Greenbelt, Maryland, February 5 - June 29, 2001.

James Wilson, University of Cincinnati, Ohio, November 30, 2000 - May 30, 2001.

James Storey, Raytheon ITSS, December 1, 2000 - June 1, 2001.

James Lynch, Jim Lynch & Associates, November 1, 2000 - April 1, 2001.

Graduate Students from University of Maryland, Department of Geography, College Park, Maryland, October 25 - April 25, 2001.
Jill Eastman
Ruth DeFries
Charlene Dimiceli
Matthew Hansen
Robert Sohlberg
Mark Carroll
Paul Davis

Xiwu Zhan, University of Maryland, Department of Geography, College Park, Maryland, October 27, 2000 - April 27, 2001.

Kendra Drob, George Mason University, Fairfax, Virginia, October 10, 2000 - April 10, 2001.

Louis Gonzalez Alvarez, Head in software development, CNRS, France, September 18 -- October 9, 2001.

Elena Martchelova Georgieva, Post Doctoral Fellow, Georgetown University, Bulgaria, August 14, 2001.

Holger Eckhardt, Staff Scientist, Kruger National Park, South Africa, July 25-28, 2001.

David Woods, Staff Scientist, Kruger National Park, South Africa, July 25-28, 2001.

Marius Canini, Electronics Designer, Cimel Electronique, France, June 29-July 3, 2001.

Jean Pierre Buis, Technical Director, Cimel Electronique, France, June 29-July 3, 2001.

Roberto V.G. Ratto, Portuguese Translator, Brazil, June 11 - August 24, 2001.

Dr. Jana Albrechtova, Assistant Professor, Charles University, Faculty of Science, Department of Plant Physiology, Czech Republic, May 1-5, 2001.

Prof. Viatcheslav I. Kharouk, Sukachev Institute of Forest, Russia, May 3-4, 2001.

Donald G. Leckie, Project Leader, Canadian Forest Service, Canada, March 9-30, 2001.

Nicholas A. Walsworth, Research Scientist, Canadian Forest Service, Canada, March 9-30, 2001.

Alkhalil N M I Adoum, Raytheon at USGS-EROS Data center, Sioux Falls, SD, May 17, 2001.

Menouer Boughedaoui, Assistant Professor, University of Blida, Algeria, May 14-17, 2001.

Sanxiong Xiong, Programmer, Science Systems & Applications, Inc., Lanham, Maryland, March 26, 2001 - December 31, 2002.

Stefania Korontzi, Faculty Research Assistant, Univ. of Maryland, Dept. of Geography, College Park, Maryland, February 26 - March 14, 2001.

Rielva Solimairy Campelo do Nascimento, PhD Student, Universidade Federal de Pernambuco, Brasil, March 9-30, 2001.

Keila de Sousa Aires, Student, Logisitcs Aide for Large-Scale Biosphere Atmosphere Experiment in Amazonia (LBA) Ecology project, Brasil, March 12-30, 2001.

Jair Max Fortunato Maia, Student, Logisitcs Aide for Large-Scale Biosphere Atmosphere Experiment in Amazonia (LBA) Ecology project, Brasil, March 12-30, 2001.

Dr. Jan Maarten Bogaert, Boston University, Dept. of Geography, Boston, Massachusetts, March 23, 2001.

Yosio Shimabukuro, Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, February 15-16, 2001.

Luc Paul Henri Blarel, Universite des Sciences et Technologies de Lille Cedex, France, February 11-23, 2001.

Alie M. Rijkeboer, Vrye Universiteit, Amsterdam, Netherlands, February 7-8, 2001.

Philippe Teillet, Canada Centre for Remote Sensing, Ottawa, Canada, January 8, 2001.

Summer Personnel for Biospheric Sciences Branch

FloJaune Griffin, Spellman Univ., Georgia GLOBE, 5/29/01, for Levine

Sohayla Hamon, Univ. Of Arkansas, EO-1, 6/4/01, for Ungar

Mike Fredenberg, Oglala Lakota College, South Dakota,Landsat/Laser Project, 5/29/01, for Williams & Nelson

Justin Hooper, Oglala Lakota College, South Dakota, Landsat/Laser Project, 5/29/01, for Williams/Nelson

Laura Kimes, Roosevelt High School, Greenbelt, MD, GLOBE, 6/26/01, for Levine

Fran Lee,Roosevelt High School, Greenbelt, MD, Space Club/EO-1, 6/25/01, for Brakke

Dr. Murray Liebowitz, Towson State, Summer Faculty Fellow/Asthsma Project, 5/29/01, for Levine

Christopher Lucas, Hampden-Sydney College, Farmville, VA, Landsat, 6/5/01, forWilliams

Tibisay Marin,Kansas State University, Landsat/Educational Outreach, 7/2/01, for Williams

Mark Miskolciz, University of Maryland, Satellite Radar Altimetry, 6/19/01, for Birkett

Chris Neigh, University of Maryland, GIMMS, 7/9/01, for Brown

Frank Niepold, Edmund Burke School, Washington, DC, Landsat/Educational Outreach, 7/2/01, for Williams

Nicole Owe, Univ. Of Maryland, GLOBE, 3/26/01, for Levine

Jon Parsons, Middlebury College, GIMMS, 7/9/01, for Tucker

Diane Pitassy, SSAI, GIMMS, 6/8/01, for Tucker

Roberta Ratto, Wilde Lake High School, Columbia, MD, LBA-Ecology, 6/11/01, for Deering

Sarah Rosenberg, SSAI, LBA-Ecology, 7/16/01, for Deering/Nadler

Lisa B. Lee Sang, Dwight D. Eisenhower Middle School, NASA/Goddard Teacher Intern Program (Prince Georges County), 7/3/01, for Stockman

Denis Sherbokov, University of Minsk, Belarus, AERONET, 6/10/01, for Holben

David Snyder, Galludet Univ., Washington, DC, Summer Faculty Fellowship, 5/29/01, for Tucker

Appendix 2 - Acronyms

AERONET	Aerosol Robotic Network
ALI	Advanced Land Imager
AVHRR	Advanced Very High Resolution Radiometer
BARC	Beltsville Agricultural Research Center
BioSAR	Biological Synthetic Aperture Radar
BSDF	Bi-directional Scatter Distribution Function
BRDF	Bi-directional Reflectance Distribution Function
CCD	Charged Coupled Device
CCRS	Canadian Center for Remote Sensing
CDDIS	Crustal Dynamics Data Information System
CF	Calibration Facility
CIESIN	Center for International Earth Science and Information Network
CHAMP	CHAllenging Mini-Satellite Payload
CMB	Core-Mantle Boundary
DAAC	Distributed Active Archive Center
DCaF	Diffuser Calibration Facility
DLR	Deutsche Zentram Fur Luftund Raumfahrt
DMSP/OLS	Defense Meteorological Satellite Programs Operation Linescan System
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
DSN	Deep Space Network
EDC	EROS Data Center
ENVISAT	ENVIronmental SATellite
EO-1	Earth Observing One (satellite)
EOS	Earth Observing System
EPSCoR	Experimental Program to Stimulate Competitive Research
EROS	Earth Resources Observing System
ERS	European Remote Sensing Satellite
ESE	Earth Science Enterprise
ESSP	Earth System Science Pathfinder
ETM +	Enhanced Thematic Mapper Plus
FAME	Full-sky Astrometric Mapping Explorer
GFO	GEOSAT Follow-On
GGFC	Goddard Geophysical Fluids Center
GIMMS	Global Inventory Mapping and Monitoring Studies
GIS	Geographic Information System
GLAS	Geoscience Laser Altimeter System
GLONASS	Global'naya Navigatsionnay Sputnikovaya Sistema (Global Navigation Satellite System)
GPS	Global Positioning System
GRACE	Gravity Recovery And Climate Experiment
GSFC	Goddard Space Flight Center
HSI	HyperSpectral Imager
IAG	International Association of Geodesy
IDS	International DORIS Service
IEEE	Institute of Electric & Electronics Engineers
IERS	International Earth Rotation Service
IGS	International GPS Service
ILRS	International Laser Ranging Service
INDOEX	Indian Ocean Experiment
IVS	International VLBI Service for Geodesy and Astrometry
LAI	Leaf Area Index
LBA	Large-Scale Biosphere-Atmosphere Experiment in Amazonia

LCLUC	Land-Cover Land-Use Change
LDCM	Landsat Data Continuity Mission
LDOPE	Land Data Operational Product Evaluation
LEO	Low Earth Orbiter
LLR	Lunar Laser Ranging
MBLA	Multi Beam Laser Altimeter
MCST	MODIS Characterization Support Team
MFF	Medusae Fossae Formation
MGS	Mars Global Surveyor
MISR	Multi-angle Imaging SpectroRadiometer
MLA	Mercury Laser Altimeter
MLL	Mixed Layer Lidar
MOBLAS	Mobile Laser Ranging Stations
MOC	Mars Orbiter Camera
MODAPS	MODIS Adaptive Processing System
MODIS	Moderate Resolution Imaging Spectroradiometer
MOPITT	Measurements Of Pollution In The Troposphere
MOSST	MOdular, Scalable, Self-consistent, Three-dimensional
NDVI	Normalized Difference Vegetation Index
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NRL	Naval Research Laboratory
NTIA	National Telecommunications and Information Administration
OMI	Ozone Measuring Instrument
ORNL	Oak Ridge National Lab
POD	Precision Orbit Determination
PRIDE	Puerto Rico Dust Experiment
RAID	Redundant Array of Inexpensive Disk
RASL	Raman Airborne Spectroscopic Lidar
RVF	Rift Valley Fever
SAFARI	Southern Africa Regional Science Initiative
SAVE	Southern Africa Validation of EOS (SAVE
SeaWifs	Sea-viewing Wide Field-of-view Sensor
SDP	Scientific Data Purchase
SLA	Shuttle Laser Altimeter
SLR	Satellite Laser Ranging
STARSHINE	Student Tracked Atmospheric Research Satellite for Heuristic International Networking Experiment
STRI	Smithsonian Tropical Research Institute
TEC	Total Electron Content
TOPEX	Ocean TOPography EXperiment
TOMS	Total Ozone Mapping Spectrometer
TRF	Terrestrial Reference Frame
USDA	United States Department of Agriculture
UNFAO	United Nations Food and Agriculture Organization
USGCRP	U.S. Global Change Research Program
USUHS	Uniformed Services University of the Health Sciences
VCL	Vegetation Canopy Lidar
VHF	Very High Frequency
VLBI	Very Long Baseline Interferometry

Appendix 3 - Grants, Contracts, Co-operative Agreements

The Laboratory for Terrestrial Physics has many efforts that involve sources of information, areas of study, and co-operations housed within, and external to, the physical confines of the Laboratory.

Grants are generally established with colleges and universities. The Laboratory has established grants or contracts totaling nearly $36M with 54 institutions of higher education, involving nearly 200 students and professors. Among those institutions involved are:

University of Alabama
University of Alaska
University of Arizona
Auburn University
Boston University
Bowie State University
Brown University
University of California
California Institute of Technology
University of California, Berkeley
University of California, Irvine
University of California, Los Angeles
University of California, San Diego
University of California, Santa Barbara
Calvin College
University of Colorado
Columbia University
Cornell University
University of South Florida
Florida State University
University of Hawaii
Harvard University
University of Indiana
Johns Hopkins University
Louisiana State University
University of Maryland, Baltimore Campus
University of Maryland, College Park
University of Massachusetts
Massachusetts Institute of Technology
University of Miami
University of Michigan
Michigan State University
University of Missouri
University of Montana
University of Nevada, Reno
University of New Hampshire
State University of New York
University of North Carolina
Northwestern University
Oregon State University
Pennsylvania State University
University of Pittsburgh

Rochester Institute of Technology
South Dakota State University
Stanford University
University of Texas
University of Utah
University of Virginia
University of Washington
Central Washington University
University of Wisconsin

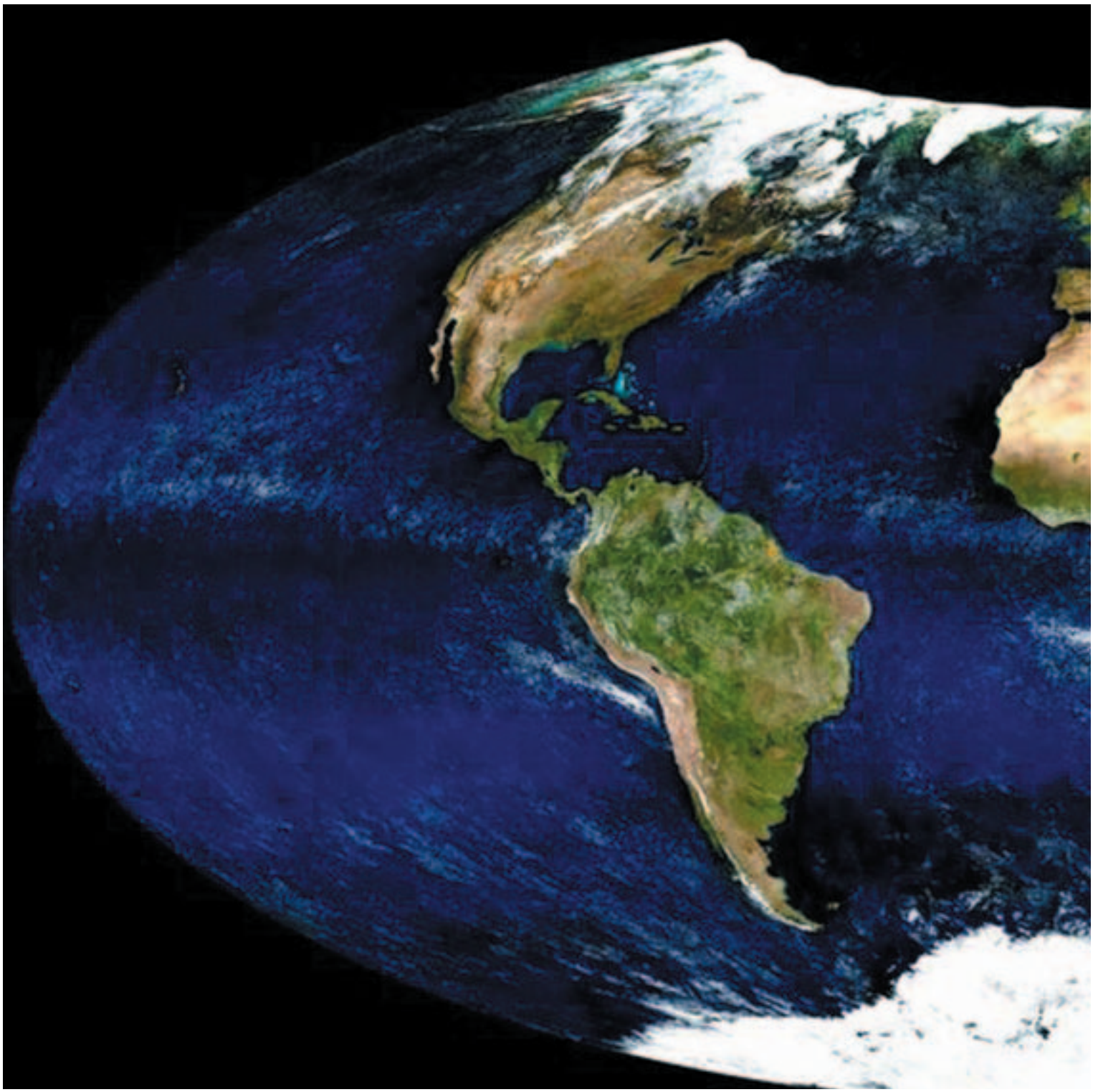
The Laboratory is responsible for grants with 3 commercial industries:

G. O. Logic
Analytical Imaging and Geophysics LLC
AER, inc.

The Laboratory holds cooperative agreements with 11 institutions, with over 30 people involved:

U.S. Department of Agriculture
UNSA (Peruvian Space Agrncy)
Desert Research Institute
Environmental Protection Agency
U.S. Geological Survey
Marine Biological Laboratory
National Center for Atmospheric Research
National Oceanic and Atmospheric Administration
Scripps Institute of Oceanography
Smithsonian Institution
Woods Hole Oceanographic Institute

Additionally, performance-based contracts are held with a number of commercial service providers. Among these are: General Sciences Corp., Global Science and Technology, Honeywell Technology Solutions, NVI, Raytheon, Science Systems and Applications, Inc., and Sigma Research.



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